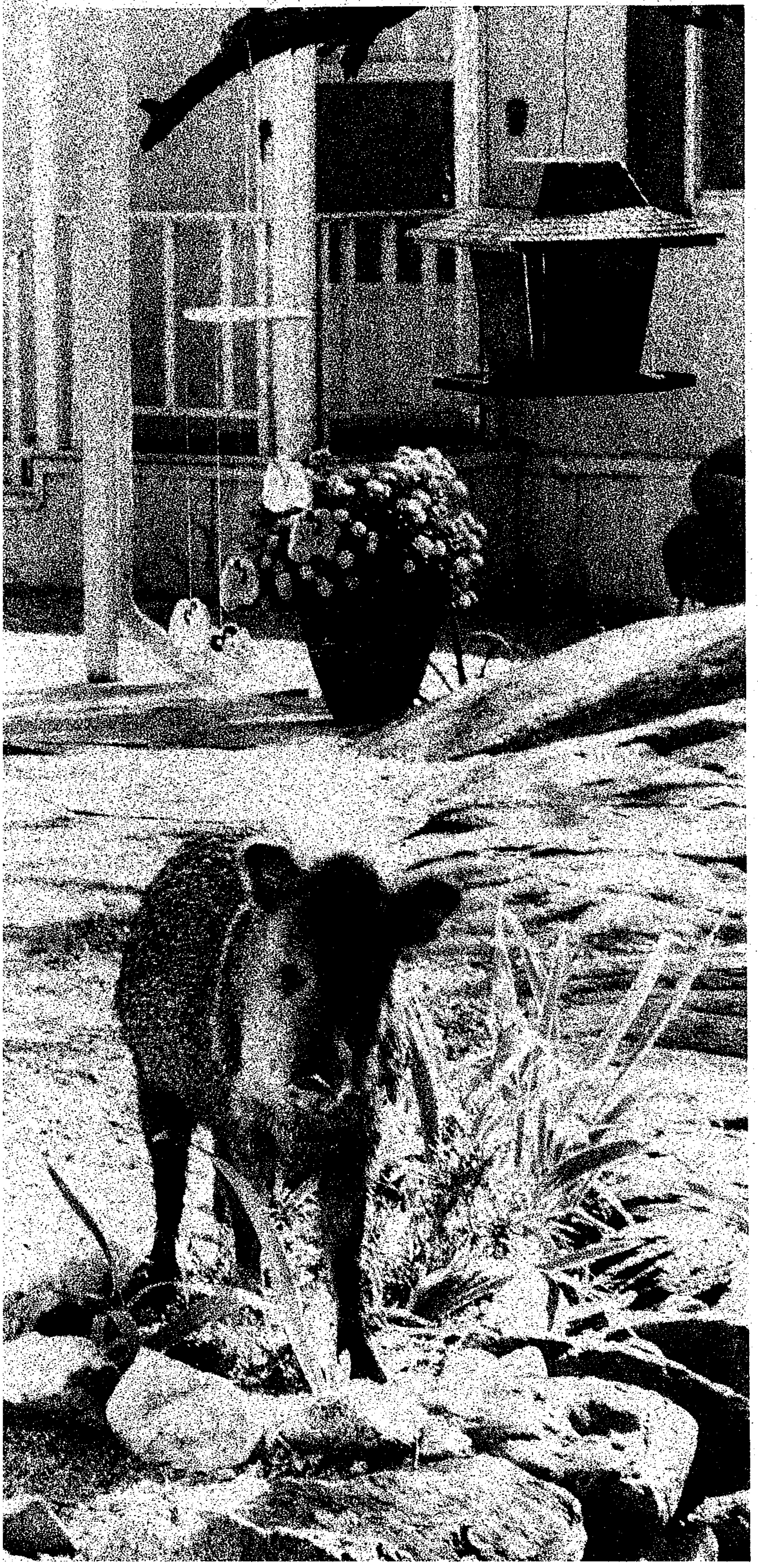
ARIZONA GAME AND FISH DEPARTMENT



RESEARCH BRANCH
TECHNICAL REPORT #14

HABITAT USE AND ACTIVITY PATTERNS OF URBAN-DWELLING JAVELINA IN PRESCOTT, ARIZONA

A Final Report

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August 1994

URBAN HERITAGE FUND

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Habitat Use and Activity Patterns of Urban-Dwelling Javelina in Prescott, Arizona

Cindy L. Dorothy Ticer, Richard A. Ockenfels, Thomas E. Morrell, and James C. deVos, Jr.

Abstract: Conflicts between homeowners and urban-dwelling javelina (*Tayassu tajacu*) in Prescott, Arizona, prompted initiation of studies to develop recommendations to alleviate these conflicts. We captured, telemetered, and located javelina during 1992-93 to determine home ranges, habitat use, and activity patterns in urban areas. Urban-dwelling javelina exhibited comparable social and territorial behavior to nonurban javelina, however, they adjusted their home ranges, home-range overlap, habitat use, and activity patterns to best use urban food, water, and cover resources. Urban-dwelling javelina selected for sites with an open woodland overstory combined with a mixed shrub understory in both developed and undeveloped areas. Urban-dwelling javelina fed on bird seed that fell from feeders, pet foods, garden tubers (e.g., tulips, grape hyacinth, and crocus), and other foods provided by homeowners. Bird baths and pet water dishes were supplemental water sources. Some homeowners also kept shallow depressions in ground-level boulder formations filled with water for javelina. Undeveloped land within or adjacent to Prescott provided javelina with daytime bedding areas. Undeveloped areas between homes provided javelina with nighttime travel corridors. Additionally, human-made structures substituted for natural escape cover from people and from adverse weather conditions. Human-javelina conflicts often occurred when javelina responded to urban attractants and destroyed ornamental landscapes or injured pets. Of the 98% of homeowners that liked wildlife in their yard, 61% preferred the wildlife not be javelina. Stepwise logistic regression of homeowner questionnaire data indicated that 3 variables were most useful in distinguishing between those yards with and those without javelina encounters. These variables were: length of residency; whether occupants fed wildlife other than javelina; and availability of ornamental plants.

INTRODUCTION

During the last 2 decades, urban-wildlife conservation has become an area of increased interest and concern (Ruther and Shaw 1990). As human populations expand into rural settings, human-wildlife conflicts invariably increase.

This pattern has occurred throughout Arizona. Reports and complaints of human-javelina conflicts have increased in many areas (i.e., Tucson, Payson, Phoenix, and Prescott) where urban developments have expanded into areas inhabited by javelina. In these areas conflicts were often numerous and included destruction of landscaping, injured pets, and frightened homeowners.

In 1991, the Arizona Game and Fish Department (AGFD) regional office in Kingman received more than 50 phone calls related to human-javelina conflicts in Prescott, Arizona (Art Fuller, AGFD, pers. commun.). As human-javelina conflicts increased, concern for the welfare of both people and javelina also increased.

Javelina, also called collared peccaries, are small to medium-sized animals, weighing 18-27 kg. Javelina evolved in the dense, tropical forests of Central America (Sowls 1984). They probably immigrated into the southwestern United States during the mid-1700s (Knipe 1956, Day 1986). In Arizona, they mainly inhabit desertscrub, semidesert grasslands, and oak woodland habitats.

Javelina are primarily herbivores, but they also consume small amounts of insects (including caterpillars and grubs) and animal matter (Sowls 1984, Day 1986). Javelina feed by rooting for underground food and cropping above-ground vegetation. Although food items vary by habitat and season, primary foods include: fruits; bulbs; rhizomes; acorns; nuts; berries; green shoots of annual and perennial plants; prickly pear (*Opuntia* spp.) cactus; and growing points of agaves (*Agave* spp.) (Leopold 1959, Sowls 1984, Day 1986).

Several predators prey on javelina. Prior to jaguar (*Felis onca)* population declines in North America, they were considered the most important javelina predator (Sowls 1984). Today, mountain lions (*F. concolor*), coyotes (*Canis latrans*), and bobcats (*F. rufus*) are the primary predators (Knipe 1956, Sowls 1984, Day 1986). Sowls (1984) and Day (1986) noted that coyote mostly prey upon young javelina. In urban situations, domestic dogs can replace coyotes as predators.

To effectively control, minimize, or eliminate conflicts, resource managers and city planners need information regarding javelina habitat use and activity patterns within urban settings. Furthermore, effective urban-wildlife management requires knowledge of what factors contribute to wildlife conflicts and how these conflicts affect human attitudes toward wildlife (O'Donnel and Van Druff 1987).

One concern frequently mentioned in homeowner complaints is the threat of javelina to children and pets. Like most wild animals, javelina prefer to avoid humans rather than confront them (Knipe 1956). However, dogs have been killed or badly injured by javelina (Knipe 1956). Occasional attacks on humans by cornered or startled javelina have also been documented. Some attacks on humans occurred when dogs encountered javelina and then retreated to their owners with the javelina in pursuit (Knipe 1956).

In most areas, javelina exist in wild situations and seldom encounter humans. However, they can adapt to human-induced habitat changes (Sowls 1984), and they can habituate to humans (Day 1986). Human-javelina conflicts can develop under 2 scenarios. Javelina can be attracted into residential areas to take advantage of food, water, and shelter sources unique to urban environments, or humans can build homes in areas used by free-ranging javelina. Both of these result in negative interactions between people and javelina (Ockenfels et al. 1985). Where this overlap occurs, javelina can cause damage to gardens and landscaping as they forage on flowers, garden vegetables, bird seed, and pet food.

Some homeowners encourage javelina visits by providing them food and water, regardless of property damage suffered by neighbors (Fig. 1). Problems also occur when homeowners tame javelina. This causes a loss of fear toward humans that often results in aggressive and dangerous behavior (Day 1986).

Javelina have long been important to Arizona's economy. They were designated big-game animals in the early 1900s (Day 1986). Today, javelina are Arizona's second-most sought after big-game animal (Perry 1985). Expenditures by javelina hunters in 1992 contributed more than 8.5 million dollars to Arizona's economy (Arizona Game and Fish Department 1992).

This investigation into the causes of and factors affecting human-javelina conflicts in Prescott was initiated so that effective management strategies to reduce the problems could be developed. The objectives of the study were to:

- Determine home-range characteristics of urban-dwelling javelina;
- Determine habitat use patterns in urban developments;
- Document activity patterns of urban-dwelling javelina;
- Identify how residential property is used by urban-dwelling javelina;
- Evaluate public attitude toward javelina in an urban environment; and
- Identify management options to reduce or prevent human-javelina conflicts.

Figure 1. Homeowner hand feeding urban-dwelling javelina in a residential area of Prescott, Arizona, 1992-93.

STUDY AREA

The study was conducted in Prescott, Yavapai County, central Arizona (elevation 1,609 m). Prescott had an incorporated area of 80 km^2. The city's periphery consisted of many low to moderate density housing developments. Approximately 28,000 people lived within its limits (Jackie Tobin, Prescott Chamber of Commerce, pers. commun.). Prescott's annual growth rate had been roughly 3.5% during the past 12 years. Predominant land uses within Prescott, ranked by percent area, were: undeveloped (50%); residential (38%); public (7%); and commercial/industrial (5%). Although Prescott had a well-developed downtown area, most residential areas consisted of single-family homes interspersed in natural areas (Fig. 2).

Topography was moderately rugged with approximately 20% of the area containing interspersed rocky outcrops. Soils were well drained and shallow and consisted largely of the Barkerville, Mirabal, and Rimrock soil series of 0-60% slopes (U.S. Dep. Agric. 1976).

Overstory vegetation consisted primarily of mixed ponderosa pine (*Pinus ponderosa*) and pinyon-juniper (*Pinus edulis-Juniperus* spp.) woodlands (Brown 1982). Understory vegetation was shrub live oak (*Quercus turbinella*), mountain-mahogany (*Cercocarpus montanus*), silk-tassel (*Garrya flavescens*), skunk-bush sumac (*Rhus trilobata*), and manzanita (*Arctostaphylos pungens*). Minimal herbaceous cover was present.

Annual precipitation averaged 71 cm; the majority fell as rainfall in afternoon summer (Jun-Sep) monsoon storms. Summer temperatures averaged 18-21 C during the day and 10 C at night. Winter temperatures rose above 10 C during the day and usually fell below freezing at night (Sellers and Hill 1974).

Figure 2. Many homes were interspersed in natural settings in Prescott, Arizona, 1992-93.

METHODS

Capture and Telemetry

During 1992, we trapped at specific residences frequented by javelina. We baited box traps with commercial wild-bird seed. Fruits and vegetables were also used, but with less success, and often lured non-target wildlife into the traps.

After capture, we routed javelina into a squeeze-chute attached to the box trap, where we then immobilized them with 7:1 mixtures of ketamine HCL (100 mg/ml) and xylazine (20 mg/ml). Mixtures were hand-injected intramuscularly at 0.22 ml per kg estimated body weight.

We marked the javelina with color-coded, numbered eartags and attached transmitter neck collars. To monitor mortality, the transmitters had a motion-sensor device that increased radio-pulse rates after 4 hours of non-movement. We released the javelina on-site once they recovered from the immobilization drugs (Fig. 3).

We attempted to trap only 1 javelina per herd. We believed that because of the javelina's social structure and their territoriality, that aside from the temporary splitting of herds and occasional movements between herds, each marked individual represented the movements of the entire herd. To avoid trapping more than 1 animal from the same herd we located each collared animal up to 30 days, thus determining its territorial boundaries, before we continued trapping in the general area.

We monitored the javelina between April 1, 1992, and March 31, 1993, in 4 residential areas of Prescott: (1) Thumb Butte; (2) Forest Trails; (3) Wildwood; and (4) Willow Creek (Fig. 4). We chose these 4 areas because of the high number of human-javelina complaints from each of them.

We monitored javelina movements during 4 time periods: (1) 0001-0600; (2) 0601-1200; (3) 1201-1800; and (4) 1801-2400 hours Mountain Standard Time. Each animal was located ≥ 1 per week during the 0601-1200 and 1201-1800 periods and ≥ 2 a week for the 1801-2400 and 0001-0600 periods. This schedule provided us with ≥ 6 weekly locations per animal.

On our initial analysis, we found no differences between the 0601-1200 and 1201-1800 periods so these were combined into a single "daytime" category for most analyses. Similarly, we combined the 1801-2400 and 0001-0600 periods into a nighttime category. We then examined if

Figure 3. Volunteer releasing radio-collared javelina in Prescott, Arizona, 1992-93.

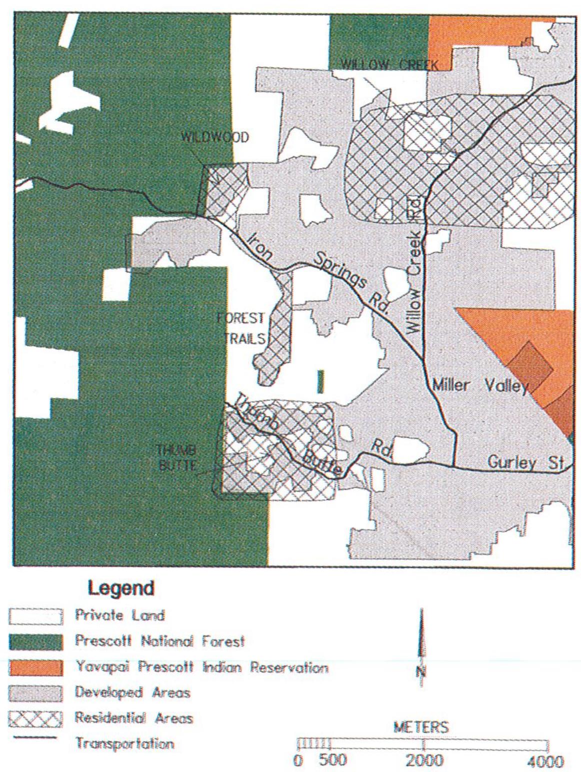


Figure 4. Residential areas of study in Prescott, Arizona, 1992-93.

temporal differences occurred in home-range sizes, in habitat use, and in activity patterns.

We chose to monitor javelina more often at night because homeowners claimed that most javelina-caused damage occurred then. When necessary, we used hand-held spotlights to observe javelina at night. Locations during consecutive periods were taken ≥ 3 hours apart to reduce the likelihood of autocorrelation. The order in which animals were located was random.

We plotted the locations on U.S. Geological Survey (USGS) 7.5′ topographic maps and derived Universal Transverse Mercator (UTM) coordinates to the nearest 0.1 km.

At the locations, we measured air temperature (C) with a thermometer, measured slope (degrees) with a clinometer, and estimated the distance (m) javelina were from escape cover. We defined escape cover as any cover capable of concealing at least a subadult javelina. Weather conditions were classified only as the presence or the absence of precipitation. Topography classes, vegetation habitat types, urban habitat types, and escape cover types were visually appraised (Table 1).

We visually observed collared animals from distances of 5-20 m to record herd composition by age class (adults ≥ 12 months; subadults = 3-12 months; and piglets ≤ 3 months). We also determined herd activity (Table 1).

Home Ranges

We determined javelina home ranges using minimum-convex polygons and core-use areas (50% minimum-convex polygons) after removing outliers (Samuel et al. 1985, Ackerman et al. 1990). We examined home-range use areas (size, area of overlap) by daytime and by nighttime and tested for temporal differences in size using a paired *t*-test. Relationships between herd size and home-range and core-use size were examined with linear correlation. Home-range overlaps were expressed as the distance (m) that 1 home range extended into another.

Habitat Selection

We generated random points to estimate habitat availability (Marcum and Loftsgaarden 1980). To do so, we first used a Geographical Information System (GIS) to create a buffer around the study area, then plotted the 452 random points that fell in the complete area; 52 of which fell within the study area. At each of these

Table 1. Variable name and description of data recorded during the javelina study in Prescott, Arizona, 1992-1993.

Variable	Description
Topography	1. Flat (0-4° slope) 2. Hillside (> 4° slope) 3. Hilltop: top 10% of hill or mountain 4. Drainage: Those areas of topography in which naturally occurring permanent and seasonal water runoff accumulates for drainage purposes. 5. Swale: The bowl-like low area between 2 adjacent hills or mountains.
Habitat Type Vegetative	1. Overstory: A. Savannah (5-10% trees) B. Open Woodland (10-30% pinyon-juniper trees) C. Closed Woodland (> 30% pinyon-juniper trees) D. Open Forest (10-30% pine-oak trees) E. Closed Forest (> 30% pine-oak trees) 2. Understory: A. Grassland-shrub (5-30% shrubs) B. Shrubland (> 30% shrubs)
Habitat Type Urban	1. Developed 2. Undeveloped
Escape Cover Type	1. Grass 2. Shrub 3. Tree 4. Rocks 5. Rocks and shrubs 6. House Structure 7. Other human-made
Activity Type	1. Moving (feeding/travel) 2. Bedded
Road Type	1. Class 2: secondary route-paved (highways) 2. Class 4: road or street-paved

52 points we established a 40-m² plot where we measured or visually estimated various habitat characteristics. We collected identical data at the random plots as we did at javelina locations. We estimated urban habitat type availability by digitizing the boundaries between developed and

undeveloped land use areas and then calculating the area in km^2.

We used a log-likelihood *G*-test contingency table to test for differences in vegetative habitat use patterns relative to time of day (Zar 1984). Vegetative habitat types were then analyzed for any differences between their use and their availability. We also used a log-likelihood *G*-test contingency table to test for differences in urban habitat type use versus availability. If *G*-tests indicated that differences occurred, we calculated Bonferroni simultaneous confidence intervals to determine which habitat types were selected or avoided by javelina (Neu et al. 1974). If avoidance or selection was detected for a particular habitat type, Jacobs' *D* was then calculated to indicate the direction and magnitude of the avoidance or selection (Jacobs 1974).

We used GIS to measure the distance (m) between each javelina location and the nearest mapped streambed and paved road (Fig. 5). This was done because we suspected streambeds were being used as travel corridors, and that paved roads may affect javelina movements within urban areas. Because the data were not normally distributed, we used Mann-Whitney U-tests to determine if time of day influenced the distance javelina were from roads and streambeds. Additionally, we tested for any differences in distance to escape cover by time of day and relative to the presence or absence of precipitation.

We used a log-likelihood *G*-test contingency table to determine if javelina use of slope differed by time of day. We then used Chi-square contingency tables, Bonferroni simultaneous confidence intervals, and Jacobs' *D* to determine if there was any daytime or nighttime selection or avoidance of slope. Finally, we used a log-likelihood *G*-test contingency table to determine if there was a difference in how javelina used topographic features between day and night. Differences were judged significant when $P \leq 0.05$.

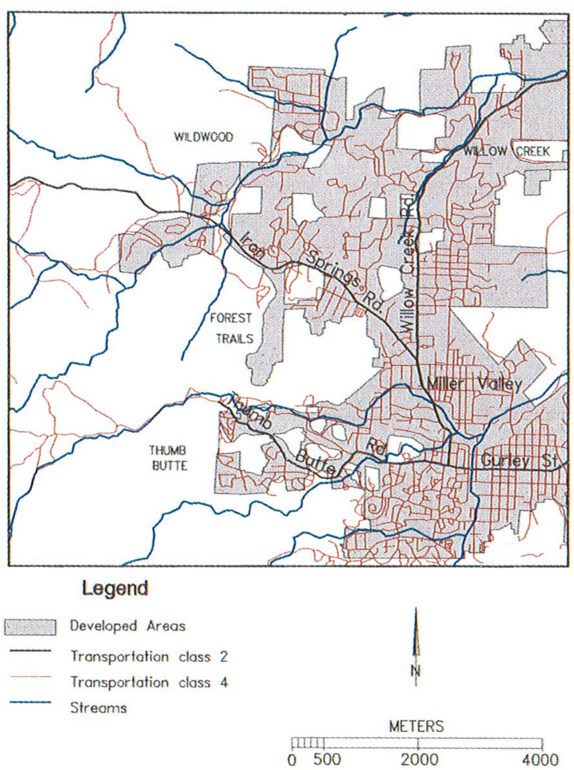


Figure 5. Road types and streams in study area of Prescott, Arizona, 1992-93.

Activity Patterns

We calculated frequency distributions of activity patterns during 4 time periods (0001-0600; 0601-1200; 1201-1800; and 1801-2400) for 4 seasons (Spring = Mar-May; Summer = Jun-Aug; Fall = Sep-Nov; and Winter = Dec-Feb). Seasonal limits were determined subjectively according to changes in the local weather. Because the activity data were categorical, we used log-likelihood *G*-test contingency tables to evaluate any activity differences among seasons, among periods within seasons, and among air temperature classes.

Homeowner Interviews

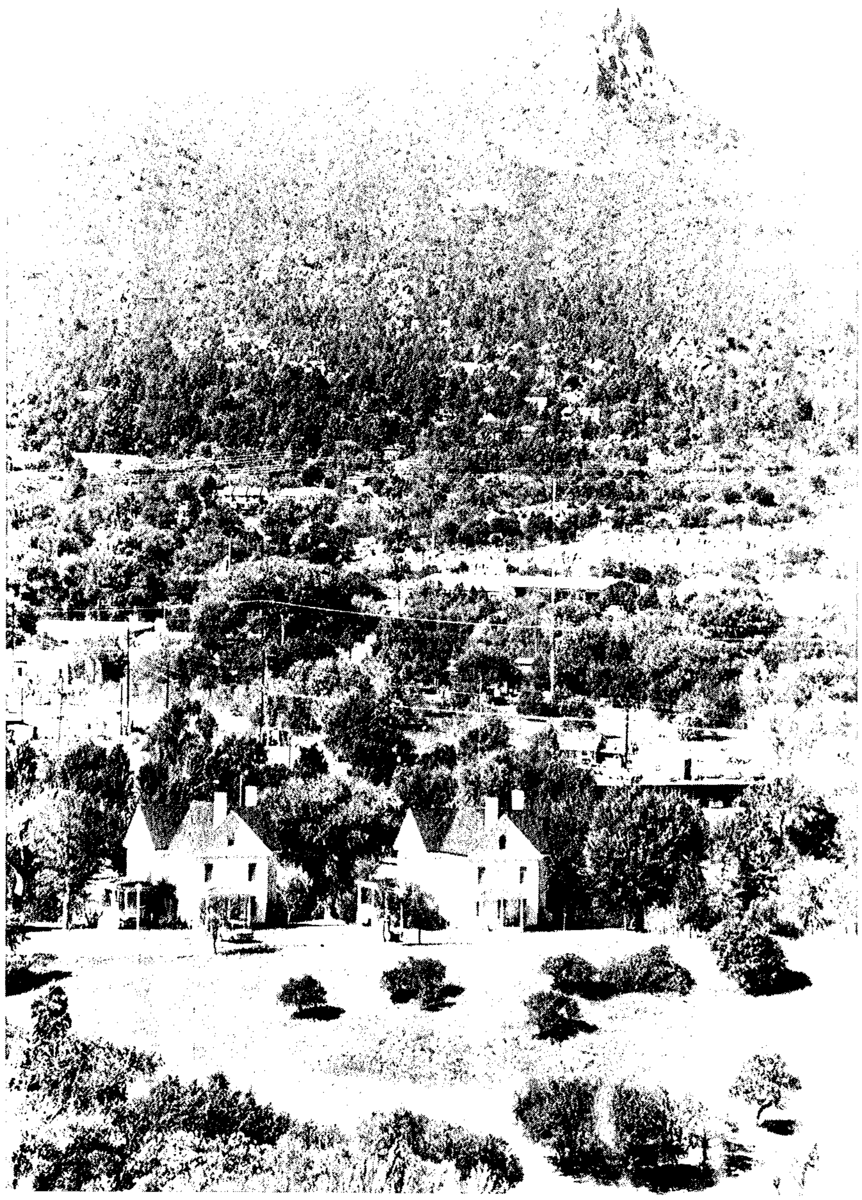
We selected Wildwood and Thumb Butte residential areas for door-to-door homeowner interviews based on our knowledge of frequent javelina activity in these areas (Fig. 6). The questionnaire (Appendix 1) included 18 questions regarding the following: human encounters with javelina; available food and water sources; vegetation eaten by the javelina; house structures discouraging or encouraging javelina encounters; homeowner period of residency; and homeowner's attitudes about wildlife.

We used Chi-square tests of independence to test for frequency distribution differences between those yards with encounters and those yards without encounters. We also evaluated interview questions to see if they were linearly correlated. If variables were correlated, 1 of the pair was excluded from further analysis.

We believed javelina used washes as travel corridors; therefore, to understand if house placement in regards to washes affected javelina use, the distance from each property to the nearest wash was visually estimated during the interview session. We then divided these distances into 3 categories ($\leq$15; 16-30; and $\geq$31 m) for analysis. We grouped years of residency into 4 categories ($\leq$1; 1-5; 6-10; and $\geq$10 years) for analysis.

Lastly, we used stepwise logistic regression to determine which home or yard characteristics were useful in distinguishing yards that had encounters from those that had no encounters (Zar 1984). Variables were kept in the regression model if tests of independence produced Chi-square P-values $\leq$0.05. P-values for variable entry and removal in models were 0.10 and 0.15, respectively (Norusis 1990). Water availability was also included in the model because we observed that javelina often used water sources in yards. Respondents who reported that an encounter occurred more than 1 year prior to the interview were not included in the analyses, because we believed home or yard characteristics could have easily changed in the long period since the encounter occurred.

Figure 6. Homeowners were interviewed to acquire information regarding their encounters with urban-dwelling javelina, Prescott, Arizona, 1992-93.



Many human-javelina conflicts occurred near Thumb Butte, a prominent landmark of Prescott.

RESULTS

Capture and Telemetry

We captured, marked, and telemetered 8 javelina (Table 2). Two collars were inadvertently placed in herd #2. It was necessary to trap individuals from 1 of the herds 3 times; the initial capture, once because of mortality, and once due to collar slippage. For analysis from herds containing more than 1 collared animal, we only used data from the first javelina caught in that herd. When it died, we then included data from the next collared animal in that herd. We monitored 6 herds for the 1-year period and accumulated 1,008 locations.

Table 2. Javelina captured and collared in Prescott, Arizona, 1992-93.

Animal	Herd	Sex	Age[a]	No. months monitored
1	1	M	SbA	4.5 (Killed by car)
2	2	M	SbA	11.0
3	3	M	SbA	11.0 (Killed by car)
4	2	F	SbA	11.0
5	5	F	Ad	10.5
6[b]	1	F	SbA	13.0
7	7	F	SbA	7.5
8	8	F	SbA	6.0 (Killed by car)

[a] SbA = subadult; Ad = adult.
[b] This animal was retrapped after losing its first collar.

Home Ranges

Home-range size averaged 493.0 ha (SD = 263.0, n = 6). Home-range sizes differed (t_d = 4.70, 5 df, P = 0.005) between day and night. Mean home-range size for days ($\bar{x}$ = 224.2 ha, SD = 156.6, n = 6) was smaller than for nights ($\bar{x}$ = 374.3 ha, SD = 195.9, n = 6). Average core area size ($\bar{x}$ = 86.0 ha, SD = 58.0, n = 6) was considerably smaller than the average home range. Home-range size was positively correlated (r = 0.64, P = 0.057, n = 6) with average herd size (Fig. 7), but core-use size was not (r = 0.46, P = 0.139, n = 6).

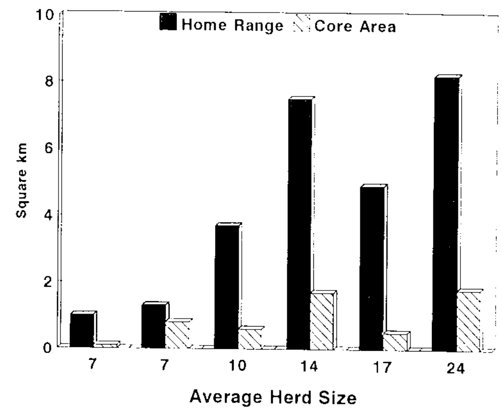


Figure 7. Changes in javelina home-range and core-use area sizes with herd size in Prescott, Arizona, 1992-93.

Javelina #3 was the only telemetered animal that wandered outside its established home range. This individual traveled ≥14.5 km from his established herd area during September 1992, stayed away for approximately 2 weeks, then returned. In April 1993, he again traveled toward the same area, but was killed by a car. A visual observation (September 11, 1992) obtained during the first excursion suggested he probably traveled alone.

Four herds had overlapping home ranges, and overlap distances ranged up to 1,000 m. Overlap in javelina home ranges occurred predominantly during night (Fig. 8). We found that overlap areas encompassed homes that routinely fed javelina. No core-use area overlap occurred.

Habitat Selection

Javelina use of vegetative habitat types did not differ by time of day, however, use of types did differ from availability (Table 3). Javelina only selected areas of open woodland overstory with a shrubland understory and avoided all other vegetation types (Appendix 2).

Javelina did not use (G = 114.65, 1 df, P < 0.001) undeveloped and developed areas in proportion to their availability either in daytime or nighttime (Table 3). Javelina primarily selected undeveloped areas during daytime and developed areas during nighttime (Fig. 9; Table 3).

The distance javelina locations were to the nearest highway (Z = -3.56, 934 df, P < 0.001), to the nearest maintained road (Z = -12.36, 934 df, P

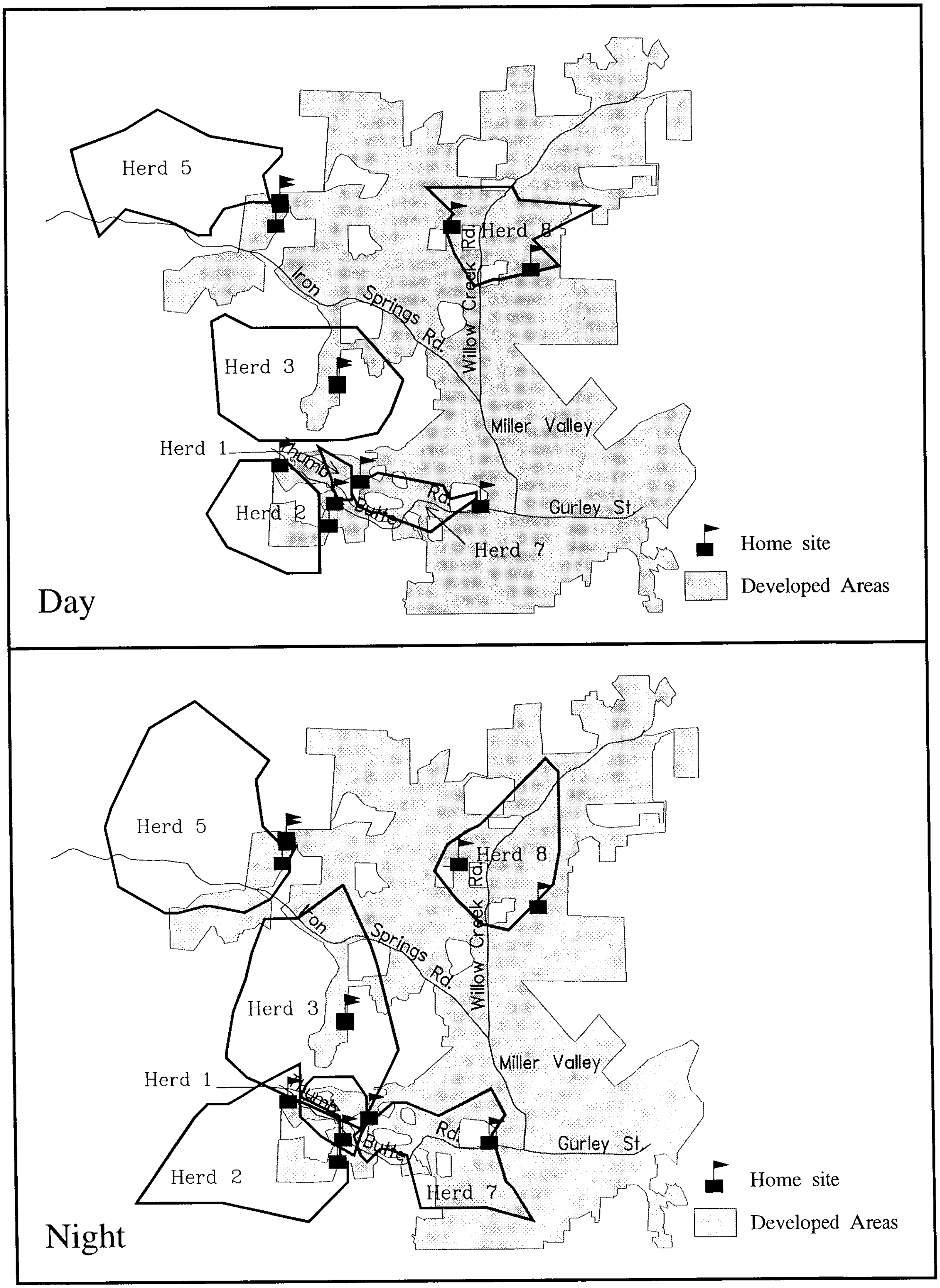


Figure 8. Overlap of javelina home ranges in relation to homes that routinely fed javelina, Prescott, Arizona, 1992-93.

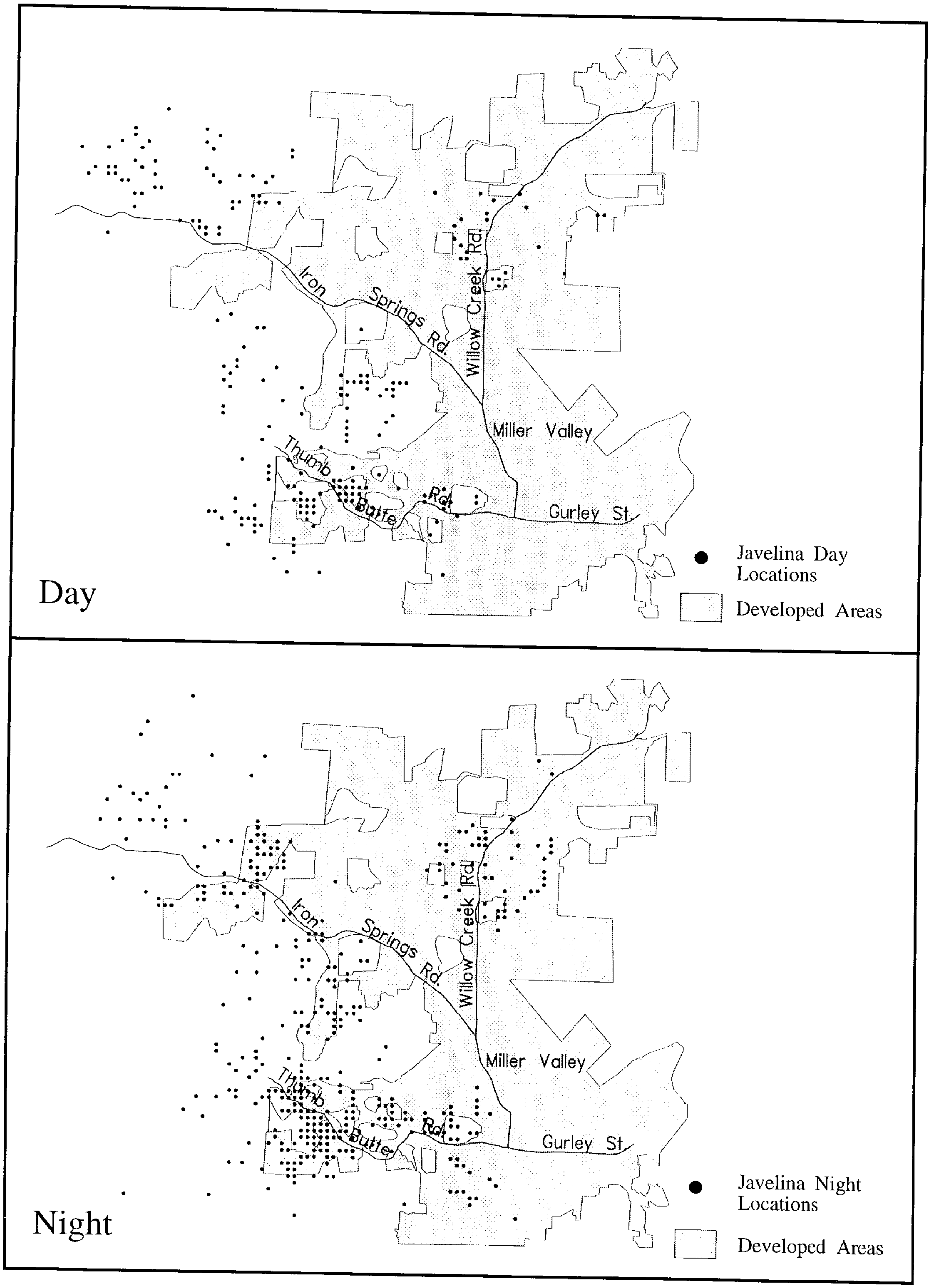


Figure 9. Urban-dwelling javelina locations relative to urban development, Prescott, Arizona, 1992-93.

Table 3. Habitat use patterns of urban-dwelling javelina in Prescott, Arizona, 1992-93.

Variable	No. locations observed	% locations observed	Bonferroni 90% CI[a]	No. locations expected	% locations expected	Jacobs' D[b]
Habitat type: Vegetative (overstory/understory)						
Open Woodland/grass-shrub	95	10.2	8.1 - 12.3	311	33.3	-0.63
Open Woodland/shrub	743	79.5	76.7 - 82.3	156	16.7	0.90
Other	97	10.3	8.2 - 12.4	468	50.0	-0.79
(G = 82.80, 2 df, $P < 0.001$)						
Habitat type: Urban						
Day						
Developed	90	22.2	18.2 - 26.2	155	38.3	-0.37
Undeveloped	315	77.8	73.8 - 81.8	250	61.7	0.37
(x^2 = 24.72, 1 df, $P < 0.001$)						
Night						
Developed	299	56.4	52.2 - 60.6	203	38.3	0.35
Undeveloped	231	43.6	39.4 - 47.8	327	61.7	-0.35
(x^2 = 34.88, 1 df, $P < 0.001$)						

[a] Bonferroni simultaneous confidence intervals calculated according to Neu et al. (1974) and Byers et al. (1984).
[b] Jacobs' D calculated according to Jacobs (1974).

< 0.001), and to the nearest stream (Z = -3.38, 934 df, P = 0.001) differed by time of day. Generally, urban-dwelling javelina were closer to these features at night. During the day the javelina spent more time on hillsides adjacent to the edge of town.

The average distance javelina were from escape cover also differed (Z = -3.23, 934 df, P = 0.001) by time of day. Javelina were closer to escape cover during the daytime, when they more often bedded directly in it ($\bar{x}$ = 1.10 m, SD = 0.92, n = 405) than at nighttime ($\bar{x}$ = 1.31 m, SD = 1.18, n = 529) when they still remained in close proximity to it.

The distance javelina were to escape cover differed (Z = -5.03, 934 df, $P < 0.001$) with the presence or absence of precipitation. Javelina were closer to escape cover when precipitation was present ($\bar{x}$ = 1.05, SD = 1.68, n = 116) than when it was not ($\bar{x}$ = 1.24, SD = 0.96, n = 818). Overall, we found that javelina did not venture far from escape cover.

Shrubs (78.4%) constituted the primary escape cover for urban-dwelling javelina. The next most common cover was rocks in combination with shrubs (11.3%). Grasses (3.2%) and trees (1.2%) were seldom used for escape cover. When houses (2.1%) and other artificial structures (0.9%) were used, it was predominantly during the night, or during extreme cold in association with rain or snow.

Javelina use of slope differed (G = 226.54, 3 df, $P < 0.001$) with time of day. Average slope used during the night ($\bar{x}$ = 9.4°, SD = 8.2) was less than during the day ($\bar{x}$ = 19.1°, SD = 9.9; Table 4).

Javelina use of topography also differed (G = 193.85, 3 df, $P < 0.001$) with time of day. More javelina locations were on flats (34.5%) and in drainages (16.0%) at night than during the day (5.9%, 3.7%, respectively). Conversely, more javelina locations were on hillsides during the day (88.9%) than at night (48.1%).

Table 4. Use of slope by urban-dwelling javelina in Prescott, Arizona, 1992-93.

Slope (degrees)	No. locations observed	% locations observed	Bonferroni 90% CI[a]	No. locations expected	% locations expected	Jacobs' D[b]
Day						
<5	53	13.1	9.3 - 16.9	160	39.6	-0.63
5-14	117	28.9	23.9 - 33.9	143	35.4	-0.15
15-24	116	28.6	23.6 - 33.6	51	12.5	0.47
>24	119	29.4	24.3 - 34.5	51	12.5	0.49
(x^2 = 108.85, 3 df, $P < 0.001$)						
Night						
<5	283	53.4	48.5 - 58.3	210	39.6	0.27
5-14	155	29.2	24.8 - 33.6	188	35.4	-0.14
15-24	49	9.2	6.4 - 12.0	66	12.5	-0.17
>24	43	8.1	5.4 - 10.8	66	12.5	-0.24
(x^2 = 21.35, 3 df, $P < 0.001$)						

[a] Bonferroni simultaneous confidence intervals calculated according to Neu et al. (1974).
[b] Jacobs' D calculated according to Jacobs (1974).

Activity Patterns

Urban-dwelling javelina activity patterns varied (G = 279.71, 1 df, $P < 0.001$) by time of day as javelina typically moved more during the night and bedded more during the day (Fig. 10).

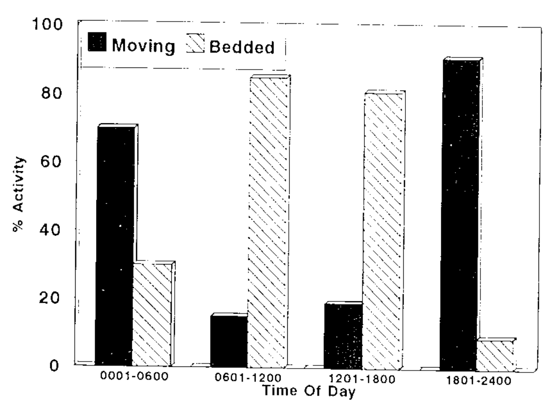


Figure 10. Temporal activity patterns of urban-dwelling javelina in Prescott, Arizona, 1992-93.

Seasonally, javelina moved more during the night in spring (G = 45.58, 3 df, $P < 0.001$), summer (G = 174.00, 3 df, $P < 0.001$), and fall (G = 91.55, 3 df, $P < 0.001$). During winter, javelina moved most (G = 72.76, 3 df, $P < 0.001$) during the early night. Javelina bedded more during the day in all seasons. During winter, javelina also bedded more during the late night (Fig. 11).

Javelina activity was dependent (G = 79.90, 5 df, $P < 0.001$) on air temperature (Fig. 12). Javelina bedded more when air temperatures were <5 or >25 C. Conversely, javelina moved mostly when air temperatures were more moderate, typically between 5 and 25 C.

Homeowner Interviews

We interviewed 348 Prescott residents (236 in Thumb Butte and 112 in Wildwood) between April and December 1992. Most respondents (228; 65.5%) reported that they had a javelina encounter within the past 12 months (Table 5).

More people had javelina encounters in their yards if they fed other wildlife (Table 5). More than two-thirds (68%) of the respondents reported feeding other wildlife in their unfenced yards; this included 151 (43%) who fed songbirds, 15 (4%) who fed hummingbirds, and 3 (1%) who fed other mammals. Just 9 people (3%) reported to us that

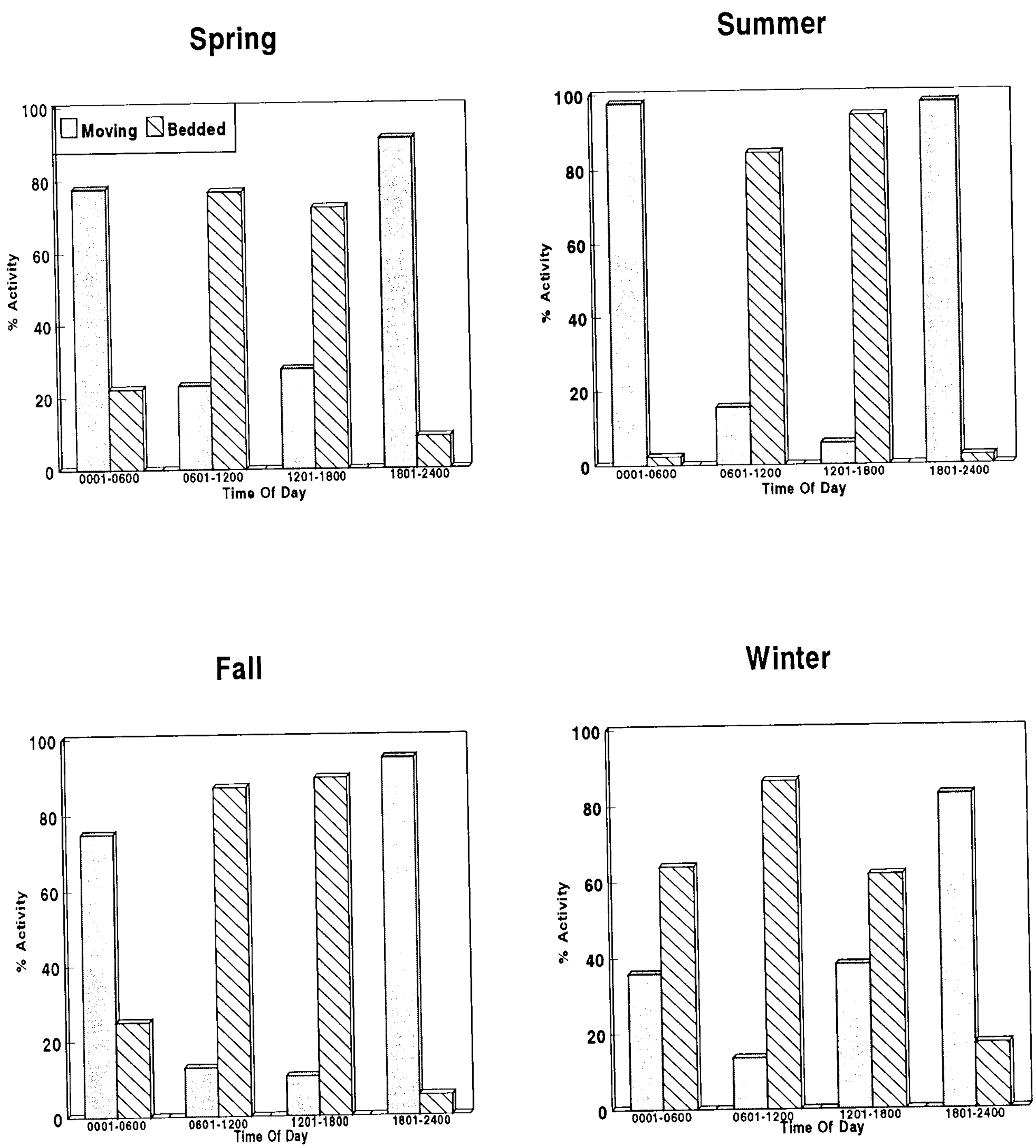


Figure 11. Seasonal activity patterns by time of day for urban-dwelling javelina in Prescott, Arizona, 1992-93.

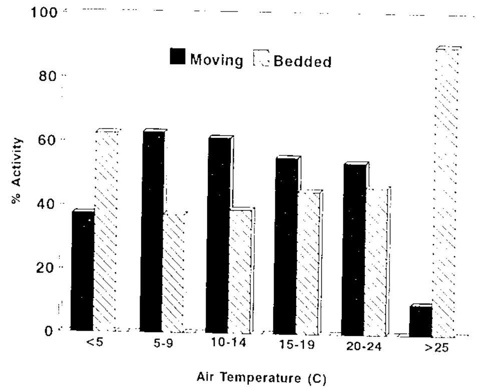


Figure 12. Urban-dwelling javelina activity relative to air temperature in Prescott, Arizona, 1992-93.

they intentionally fed javelina in their unfenced yards. The ratio of encounters to no-encounters was 2.3 times greater in those yards where other wildlife was fed.

Most encounters (81%) occurred in yards where ornamental plants were available to javelina. The ratio of encounters to no-encounters was 2.3 times greater in yards where ornamental plants were available. Vegetation most often reported by homeowners to be eaten by javelina were ornamental tuberous flowers, vegetables, and fruits (Appendix 3). Tulips (*Tulipa spp.*) and grape hyacinth (*Muscari spp.*) were the ornamentals most often reported to be consumed by javelina. In contrast, Iris' (*Iris spp.*) and daffodils (*Narcissus spp.*) were ornamentals avoided by javelina (Appendix 4). Squash (*Cucurbita spp.*) and tomatoes (*Lycopersicon spp.*) were vegetables most often eaten by javelina, whereas pepper (*Capsicum spp.*) was the only vegetable javelina consistently avoided.

The proportion of yards with encounters compared to yards without encounters became larger as the years of residency increased (Table 5).

Table 5. Results of 348 homeowner interviews conducted in Prescott, Arizona, 1992-93.

Variable		Number of Responses: Encounter	No Encounter	Chi-square value	df	P-Value
Feed other wildlife	Yes	163	28	7.70	1	0.005
	No	65	26			
Water	Yes	86	12	4.62	1	0.031
	No	142	42			
Ornamental	Yes	184	35	6.35	1	0.011
	No	44	19			
Garden	Yes	37	4	2.75	1	0.100
	No	191	50			
Distance to wash	<15 m	146	31	2.13	2	0.344
	16-30 m	39	8			
	>30 m	43	15			
Years of residence	1	20	21	5.77	3	0.001
	1-5	74	18			
	6-10	37	6			
	>10	97	9			
Number of people	1	44	12	1.02	3	0.079
	2	141	33			
	3	26	4			
	>4	17	5			

We found only 49% of the respondents living ≤ 1 year at a residence reported encounters, whereas 91.5% of those at a residence for >10 years reported encounters.

Although water availability did not improve our regression model, it was a resource used by urban-dwelling javelina. We found 87% of the yards with water had encounters and only 77% of those yards without water had encounters.

One hundred seventy-seven respondents (50.9%) indicated that living in close proximity to a natural area was the primary reason they chose to live where they did (Table 6). Moreover, 307 participants (88%) believed that their close proximity to natural areas influenced the amount of wildlife in their yards (Table 6).

Almost all respondents (97.7%) reported that they liked wildlife in their yards, but 213 (61.2%) indicated that they do not like javelina in their yard (Table 6). Thus, nearly two-thirds of the respondents who liked wildlife in their yard preferred that javelina were not included. Forty-six percent of those interviewed indicated they had moderate or great concern about having javelina in their neighborhood. Eighty-eight (25.3%) respondents told us that they had, at some time, used a deterrent to try to keep javelina out of their yard. Most of these deterrents were only temporarily effective. Only fences, including hot-wires, were successful in permanently keeping javelina out of yards.

Stepwise logistic regression showed that 3 variables were most useful in distinguishing between those yards where encounters occurred and those yards without encounters: (1) length of residency; (2) whether occupants fed wildlife other than javelina; and (3) if ornamental plants were available to javelina (Table 7). These 3 variables significantly improved the fit of the model. The final model provided an overall correct classification of 83.7% (for no-encounters = 27.8%; for encounters = 96.6%). The addition of available water did not substantially improve our ability to correctly classify yards with or without encounters. The probability of a homeowner having a javelina encounter was independent of the availability of gardens, their home's distance to washes, and number of people living at that residence.

Table 6. Responses to 6 questions asked of 348 homeowners in Prescott, Arizona, 1992-93.

	Question	Response	
1.	How important was being close to a wild, natural area in your decision to live in this location?	Not important	84
		Slightly important	87
		Primary reason	177
2.	Do you think your close proximity to wild, natural areas influences the amount of wildlife found in your neighborhood?	Yes	307
		No	37
		Unknown	4
3.	Do you like wildlife in your yard?	Yes	340
		No	8
4.	Do you like javelina in your yard?	Yes	135
		No	213
5.	What degree is your concern regarding javelina?	None or little	189
		Moderate concern	104
		Great concern	55
6.	Have you used deterrents on javelina to keep them out of your yard?	Yes	88
		No	260

Table 7. Results of stepwise logistic regression model to distinguish between yards with and without javelina encounters in Prescott, Arizona, 1992-93. The model was based on 54 residences with no javelina encounters and 228 residences with javelina encounters.

Variable	Coefficient	SE of Coefficient	Improvement Chi-square		Goodness-of-fit Chi-square	
			x^2	P-value	x^2	P-value
Feed other wildlife	0.939	0.335	6.9	0.008	289.4	0.292
Ornamentals	0.837	0.359	4.9	0.026	273.8	0.525
Years of residence	0.785	0.159	31.3	<0.001	281.9	0.421
Constant	-1.705					

DISCUSSION

Home Ranges and Habitat Use

As with nonurban javelina, the urban-dwelling javelina established overlapping home ranges, with core-use areas used exclusively by the herd occupying the home range (Jewell 1966; Schweinsburg 1969, 1971). Urban-dwelling javelina, however, displayed a larger average home-range size and area of overlap than nonurban herds (Day 1986). In Tucson, deVos et al. (1983) also found home ranges of urban-dwelling javelina to be larger than those of nonurban herds. However, this may not always be the case, as Bellantoni and Krausman (1991) found no difference between the 2 classes. We also observed that home-range size of urban-dwelling javelina, like nonurban javelina, increased with herd size (Day 1986).

Importantly, movement patterns of urban-dwelling javelina were more widespread at night than during the day. We suspect this was due to their traveling between developed and undeveloped areas in search of food at a time period with minimal human disturbance.
We observed home-range overlap only at night when javelina traveled to permanent food sources provided by some homeowners. Although home-range overlap occurred, interactions between herds were limited because herds typically used these common feeding sites at different times during the night (Jackie Summers, pers. commun.).

Larger home ranges of some urban-dwelling javelina possibly resulted because these javelina traveled to urban areas at night to use homeowner-provided food sources, but then returned to natural areas to meet their daytime bedding requirements. In support of this theory, we found the home ranges of javelina herds on the periphery of town were much larger than those herds whose home ranges existed entirely within the city, with all living requirements (food, water, and cover) close by (Fig. 13).

Although urban-dwelling javelina fed on the alternate food sources provided by homeowners during nighttime, like nonurban javelina they also foraged for food during daytime (Sowls 1984, Day 1986). Interestingly, we observed that herds that existed solely within city boundaries foraged within residential areas more often during daytime than did those herds living on the city periphery. These herds exhibited signs of tameness when being fed by homeowners, however, they easily became aggressive when the homeowner did not provide food quick enough (Fig. 14). In fact, the arcadia doors of homeowners who regularly fed javelina were often smudged with javelina nose prints. Some javelina went as far as following their "feeder" down the road while waiting for food to be thrown.

Figure 13. Javelina day-use area in Prescott, Arizona, with daytime bedding area and natural and human-provided food and water sources.

The movement of javelina #3 outside its home range was not unusual. Individual nonurban adult

Figure 14. Aggressive display by an urban-dwelling javelina, Prescott, Arizona, 1992-93.

male javelina are more mobile than females (Supplee 1983) and have been documented traveling far outside their home ranges (Day 1977, Supplee 1983, Oldenburg et al. 1985, Bellantoni and Krausman 1991). Although the motivation for javelina #3 to make such long movements is unknown, Supplee (1983) speculated that such movements may be related to low status in the herd hierarchy; that results in unavailability of mates. Bissonette (1976) hypothesized that javelina would disperse in response to herd crowding and mating competition.

Roads are a danger to urban-dwelling javelina. At night, javelina were closer to roads in residential areas than during the daytime. Generally, javelina would wait in or adjacent to available cover until traffic was clear, then cross the road in single file. On numerous occasions, we observed traffic swerving or stopping to avoid hitting javelina. These observations, coupled with a 38% car-related mortality of our collared javelina, suggested that javelina-car collisions are numerous and may affect population growth in an urban setting.

Urban-dwelling javelina used streams as nightly travel corridors between developed and undeveloped areas. Streams provided continuous ribbon-like expanses of undeveloped cover, similar to the cover preferred by nonurban javelina (Sowls 1984, Day 1986). Javelina, much like urban deer (Vogel 1989), used densely-vegetated runways and small washes to travel through urban areas.

Our study supports deVos et al. (1983) and Bellantoni and Krausman (1991), in that we also found urban-dwelling javelina closer to developed areas at night. We grossly defined all residential areas of Prescott as "developed." However, large portions of many areas were actually a matrix of homes in a natural or undeveloped setting. In most cases, no structural boundaries physically separated the developed sites from undeveloped areas. As a result, our analyses on development may be biased; many developed areas in Prescott are not tract-home sites. The occurrence of structural boundaries, such as fences, increased with increased housing density closer to the city center. The frequency of javelina locations greatly decreased in these fenced residential areas.

Urban-dwelling javelina predominantly used the flats and streams when moving through developed areas at night (Fig. 15); then they

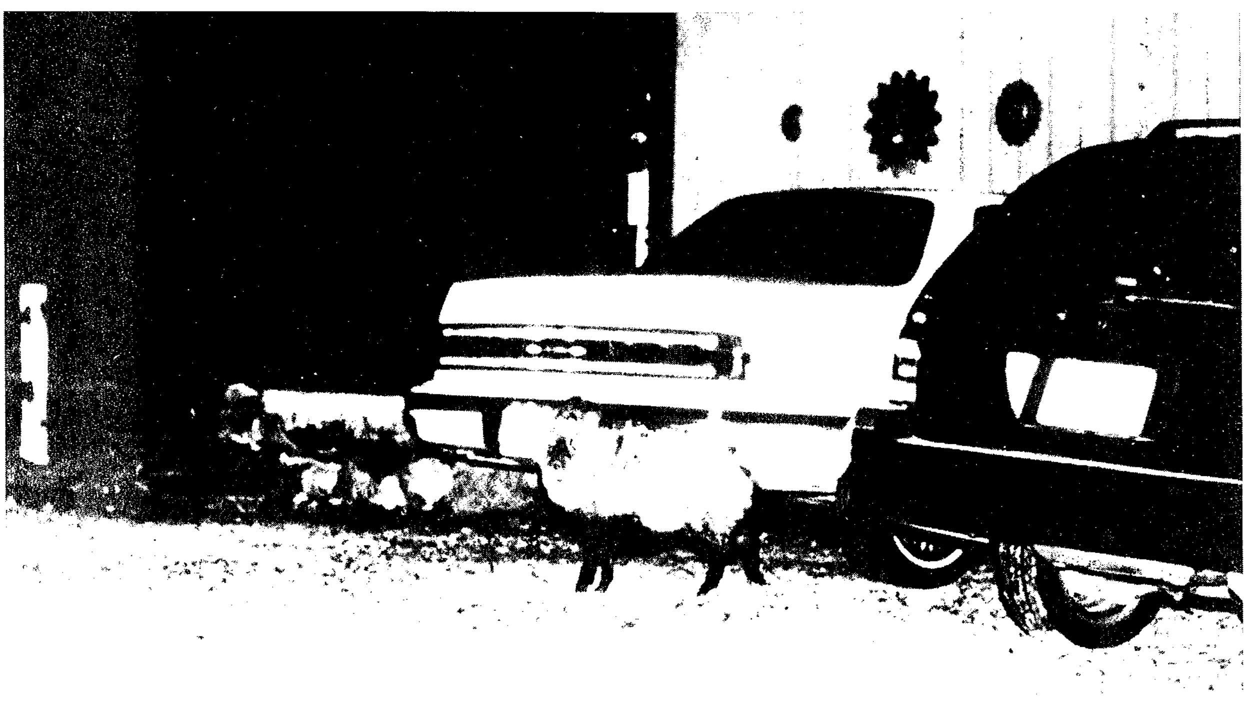


Figure 15. Urban-dwelling javelina moving through a residential area at night in Prescott, Arizona, 1992-93.

returned to the security of undisturbed hillsides for daytime bedding. Vogel (1989) had observed a similar behavior in urban-dwelling deer in Montana. Those deer used flats in developed areas when moving and feeding at night, then retreated to steeper, undeveloped slopes for daytime bedding. Steep, undeveloped areas within or adjacent to urban areas are likely to have low use by people, thereby providing urban wildlife with an undisturbed day-use area.

Similar to nonurban javelina, urban-dwelling javelina used dense vegetation and rugged topographic features for hiding and escape cover (Day 1986). However, urban-dwelling javelina also used homes and other human-made structures for escape and thermal cover (i.e., to avoid heavy rain or freezing temperatures) during day or night. Javelina have long been known to thrive in cut-over and agricultural areas (Leopold 1959, 1966) as long as suitable cover was available nearby for daytime hiding (Sowls 1984). The same situation seems to occur in urban areas.

Activity Patterns

We believe observed javelina activity patterns were related to their hiding and thermal needs. Urban-dwelling javelina activity patterns were similar to nonurban javelina. They predominantly bedded during daytime hours, and they fed and traveled at night (Day 1986). Urban-dwelling javelina exhibited similar seasonal variation in activity patterns to those of nonurban javelina (Eddy 1961, Ellisor and Harwell 1969, Schweinsburg 1969, Bigler 1974). The main difference in activity was that urban-dwelling javelina were more nocturnal year-round. Vogel (1989) observed a similar shift toward increased nocturnal activity for urban-dwelling deer. Increased nocturnal activity by urban wildlife may be the result of increased food sources and lower human disturbance levels at nighttime. Maximizing nighttime feeding activity when human disturbance is low and when urban predators, such as dogs, are less likely to be out has obvious benefits.

Urban-dwelling javelina activities were not influenced by precipitation, and similar results were observed by Jennings and Harris (1953), Schweinsburg (1969), and Bissonette (1978). We also found urban-dwelling javelina activity patterns to be largely controlled by ambient temperature. Schweinsburg (1969) observed that nonurban javelina typically ceased feeding and bedded more when air temperatures approached or exceeded 26.5 C. Eddy (1961) had previously observed this behavioral response in nonurban javelina, but at higher air temperatures (31-33 C).

Similar to nonurban javelina, urban-dwelling javelina became more active during daytime hours in the winter (Day 1986). Zervanos (1972) suggested that any increase in daytime javelina activity in winter is in response to increased thermoregulatory demands.

When we found urban-dwelling javelina bedded during lower temperatures, they were often piled one on top of another (Fig. 16). Sowls (1984) postulated that javelina bed in huddled groups to prevent heat loss when temperatures drop to a point where it would be inefficient (in terms of energy loss) to continue feeding.

Naturally-occurring bedding cover for javelina in Prescott did not seem to provide adequate thermal protection during extreme cold periods. During such times we often found them bedded underneath homes or house structures, day or night. This particularly happened when there was snow on the ground.

Although studies conducted on nonurban javelina found increased daytime activity only during winter, we also observed an activity increase during spring. We attribute this to the low seasonal temperatures of Prescott. The higher elevation of Prescott causes seasonally lower temperatures compared to the lower deserts where most javelina studies have been conducted. Therefore, increased daytime activity in winter and spring is congruent with expected behavioral patterns. It is a temperature-driven behavior more than it is a seasonally-driven behavior.

Urban Landscapes

Perhaps proportionately more encounters with javelina occurred with increasing years of residency because most homeowners continued landscape improvements (e.g., they planted ornamental flowers and gardens) as long as they resided at a particular location. Thus, javelina would find more abundant resources at homes where gardens and landscaping had been developed over many years (Fig. 17). Additionally, fewer encounters may have been reported by recent residents, because they may not have noticed if javelina had entered their yards. On several occasions we found javelina

Figure 16. Javelina often pile one on top of another for thermoregulation during cold temperature periods.

Figure 17. Many homes were unfenced and contained abundant ornamental vegetation and water sources that urban-dwelling javelina used, Prescott, Arizona, 1992-93.

sign in yards of homeowners that had not detected the sign. In contrast, long-term residents, already familiar with javelina, were more likely to detect javelina sign.

Many respondents indicated that bird seed, alfalfa pellets, and table scraps put out for other wildlife were consumed by javelina. In many cases we noted that occupants had taken measures (e.g., removal of available water or ornamental plants) to prevent javelina from coming onto their property, yet they were inadvertently attracting javelina by feeding songbirds. Javelina made regular visits to yards with bird feeders to eat fallen seed (Fig. 18).

In addition, the soils of Prescott typically contained enough organic matter to harbor numerous grubs (beetle larvae). These grubs are very nutritious, and javelina, as well as skunks, raccoons, and foxes, dig for them. During summer, the grubs feed on decaying vegetation and on living plants close to the ground surface, but at the onset of cold weather they move deeper into the soil (Fernald and Shepard 1942). Because of this, winter digging by javelina created the most destruction.

Many homeowners in Prescott used unsterilized horse manure for gardening and may have unsuspectingly introduced large quantities of grubs into their gardens. Although many wildlife species dig for grubs, javelina likely cause the most damage. Even if garden plants are not actually consumed, javelina rooting causes considerable soil disturbance that can expose plant roots or uproot the plants.

Urban-dwelling javelina are opportunistic feeders. We examined vegetation eaten by javelina (Appendix 3) and those not eaten (Appendix 4), and we observed that ornamental, and wild, edible bulbous flowers, vegetables, and fruit were readily consumed by javelina. Therefore, these kinds of plants need protection. Some ornamental plants provide javelina with a better source of nutrition, and they are apparently more palatable than many native species. In addition, ornamental plants may be available in greater densities than naturally-occurring species in wild areas. Moreover,

Figure 18. Urban-dwelling javelina often fed on wild-bird seed that was spilled onto the ground in Prescott, Arizona, 1992-93.

ornamental plants are likely to be frequently watered and may assist in meeting javelina water requirements.

Human Attitudes

Although many people indicated that they liked wildlife around their property, the majority indicated that they did not want javelina in their yard. In spite of this feeling, most people indicated that living in a relatively undeveloped, natural area was the primary reason for living where they did. People who reported great concern about javelina indicated that damage to their property (e.g., losses of flowers and garden plants) and harm to themselves or their pets by javelina were the main reasons for their concern.

Our inquiries regarding javelina attacks on dogs revealed that typically the dog had somehow threatened (charged, lunged, barked, etc.) the javelina first. Thus, javelina attacks were responses to an attack. Our study observations suggest javelina will usually avoid or pay little attention to dogs restrained behind fences. In urban areas used by javelina, conflicts could probably be avoided by people better controlling their dogs at night when javelina are most active.

Although we observed damage to gardens by other wildlife species, homeowners generally did not complain to us about any damage unless they believed it was caused by javelina. The javelina's "dangerous" reputation could have been the primary reason people were so concerned only about javelina. Additionally, we suspect homeowners complained about javelina because they readily assumed all property damage was caused by javelina. Furthermore, we observed that some homeowners unaffected by javelina had a strong dislike for the animals, and the closer they lived to an affected homeowner, the more intense the dislike.

Fences were an effective barrier to javelina. All respondents who built a javelina-proof fence told us their javelina problems promptly ceased. Some respondents, who enjoyed watching javelina in their yard, built only small fences to preclude javelina use in selected areas. Many respondents reported that single-strand electrical fences were effective in reducing javelina use of their yards (Fig. 19). Single-strand, electrical fencing was very useful in areas where housing covenants prohibited homeowners from erecting more substantial fences.

To ensure safety for people, pets, and other wildlife, very low-voltage hot-wires were used. It appears to us that voltage level did not matter for effectiveness. The wire only needed to be activated during times when javelina were most

Figure 19. Single-strand electrical hot-wire fencing was very successful in protecting gardens from urban-dwelling javelina in Prescott, Arizona, 1992-93.

likely active, and it could be turned off after the herd was exposed several times.

In some instances, occupants of a neighborhood took efforts to remove attractants such as bird seed or water, yet javelina activity continued unabated. This probably occurred because other nearby residents continued to provide javelina attractants. If a yard in a neighborhood had food or water available to javelina, the animals continued to regularly visit the entire area. Thus, actions by individual homeowners toward javelina affected their neighbors.

CONCLUSIONS

Javelina have adapted to conditions in Prescott by using the food, water, and cover sources provided by homeowners. It is apparent that homeowners have improved the habitat quality, thereby allowing javelina to survive in the urban setting.

The human population of Prescott is increasing, with the majority of the newcomers from urban California (Prescott Chamber of Commerce, pers. commun.) where interactions with wildlife were often limited. These newcomers lack sufficient knowledge of how to rid their homes of wildlife, and they do not readily have information on how to prevent wildlife-caused damage.

To the frustration of many Prescott homeowners, urban-dwelling javelina do not discriminate between food sources in yards where they are welcome and those where they are not. Another problem results when homeowners tame javelina to the point that they no longer fear humans. Effective javelina management in urban areas will require a concerted effort by all homeowners and government agencies. To prevent or reduce javelina use, homeowners will need to coordinate with their neighbors to remove all javelina attractants, such as preferred ornamental plants, wild-bird seed, pet food, table scraps for other wildlife, and water. Fencing may be required in some areas to eliminate the problem. Agencies may need to enact regulations that preclude feeding of all wildlife in unfenced yards.

However, with the exception of fencing, these actions may be difficult to implement. Although most homeowners do not want javelina in their yards, those feeding javelina appear unwilling to forego encouraging javelina in their neighborhood. Therefore, homeowners wanting to exclude javelina from their yards would have to look toward strategies such as constructing fences or putting in hot-wires.

If future development occurred from within the central core of the city's boundary and gradually progressed outward, then we suspect javelina would be pushed in the same direction. However, javelina existing around the city's perimeter would still continue to frequent the city for available resources (Fig. 20). Therefore, as long as undeveloped pockets of land or densely-vegetated travel corridors remain within the city, and homeowners provide wildlife with supplemental food and water, javelina will continue to thrive near residential areas and human-javelina conflicts will continue. Basically, the problem is one of managing people more than it is managing javelina.

Figure 20. Urban-dwelling javelina feeding at a residence in Prescott, Arizona, 1992-93.

MANAGEMENT OPTIONS

Results of our homeowner interviews coincided with other studies (Ruther and Shaw 1990) in that the majority of the urban public is interested in and enjoys wildlife in urban areas. Unfortunately, conflicts have sometimes developed between homeowners and javelina. Such conflicts have placed emphasis on the need for resource agencies and planning and zoning commissions to develop strategies for managing javelina inhabiting urban areas. In reality, such management strategies will have to mainly target homeowners and not the javelina.

The following options have been developed to assist in reducing conflicts between homeowners and javelina. Each of these options can reduce conflicts, however, a combination of actions may be required to be most effective.

1. Fence fruits, vegetables, tuberous flowers, or entire yards from javelina (Fig. 21). Fencing options are listed in Appendix 5.

2. Education:
   (a) Provide homeowners with information about the local wildlife, including information on methods to reduce the presence of unwanted wildlife.

   (b) Provide information about plants most likely to be eaten by javelina and those that are not (Appendixes 3-4).

   (c) Distribute this information widely, including various Chambers of Commerce and planning and zoning commissions.

3. Test various taste aversion substances, repellents, and ultrasonic chaser devices on captive and free-ranging javelina.

4. Encourage local gardeners to avoid using unsterilized manure for gardens because it may harbor the beetle larvae (grubs) that javelina and other wildlife dig for. Encourage the treatment of grub-infested gardens with a substance that is non-toxic to wildlife.

5. Consider implementation of local laws and ordinances that preclude feeding wildlife in unfenced settings.

Figure 21. Woven-wire fencing used to protect vegetable garden from urban-dwelling javelina, Prescott, Arizona, 1992-93.

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Appendix 1. Eighteen questions used in homeowner interviews to study javelina-human interactions in Prescott, Arizona, 1992-93.

1. Have you had a javelina encounter at your present residence within the past year (yes, no)?
2. Do you intentionally feed javelina on your property (yes, no)?
3. What kind of wildlife other than javelina do you intentionally feed on your property?
4. Is there an available water source for javelina in your yard (yes, no)?
5. Are there any ornamental plants available to javelina in your yard (yes, no)?
6. What type of vegetation do javelina most often consume in your yard?
7. Which ornamental plants do javelina most often consume in your yard?
8. Is there a garden available to javelina in your yard (yes, no)?
9. Which garden plants do javelina most often consume in your yard?
10. How many years have you lived at the present address (<1, 1-5, 6-10, or >10 years)?
11. How many people live in your house?
12. Do you have outside lighting on your property (no; yes, lights are on part of the night or are on all night)?
13. How important was being close to a wild, natural area in your decision to live in this location (primary reason, slightly important, not important)?
14. Do you think your proximity to wild, natural areas influences the amount of wildlife found in your neighborhood (yes, no)?
15. Do you like wildlife in your yard (yes, no)?
16. Do you like javelina in your yard (yes, no)?
17. What level of concern do you have regarding javelina in your yard (little concern, moderate concern, great concern)?
18. Have you ever used deterrents, other than fences, on javelina (yes, no)?

Appendix 2. Frequencies of vegetative habitat descriptions, as defined in Table 1, at javelina locations in Prescott, Arizona, 1992-93.

Herd No.	Habitat Type Over/Under	Number of Locations	% Locations
1	Open woodland/shrubland	128	85
	Open woodland/grassland-shrub	12	8
	Closed woodland/shrubland	7	5
	Savannah/grassland-shrub	4	3
2	Open woodland/shrubland	160	85
	Open woodland/grassland-shrub	9	5
	Closed woodland/shrubland	15	8
	Savannah/grassland-shrub	4	2
	Savannah/shrubland	1	1
3	Open woodland/shrubland	135	77
	Open woodland/grassland-shrub	19	11
	Closed woodland/shrubland	18	10
	Savannah/grassland-shrub	1	1
	Open forest/grassland-shrub	1	1
	Riparian/grassland-shrub	1	1
5	Open woodland/shrubland	140	74
	Open woodland/grassland-shrub	17	9
	Closed woodland/shrubland	4	2
	Savannah/grassland-shrub	11	6
	Savannah/shrubland	17	9
	Open forest/shrubland	1	1
7	Open woodland/shrubland	98	77
	Open woodland/grassland-shrub	20	16
	Closed woodland/shrubland	1	1
	Savannah/grassland-shrub	9	7
8	Open woodland/shrubland	82	80
	Open woodland/grassland-shrub	18	18
	Savannah/grassland-shrub	1	1
	Riparian/grassland-shrub	1	1
Total	Savannah/grassland-shrub	30	3
	Savannah/shrubland	18	2
	Open woodland/grassland-shrub	95	10
	Open woodland/shrubland	743	80
	Closed woodland/shrubland	45	5
	Open forest/grassland-shrub	1	<0
	Open forest/shrubland	1	<0
	Riparian/grassland-shrub	2	<0

Appendix 3. Available plants typically eaten by urban-dwelling javelina in Prescott, Arizona, 1992-93.

Ornamental		Native	
Common Name	Scientific Name	Common Name	Scientific Name
Squash	*Cucurbita* spp.	Prickly Pear pads	*Opuntia* spp.
Corn	*Zea* spp.	Prickly Pear fruit	*Opuntia* spp.
Cabbage	*Brassica oleracea*	Manzanita berries	*Arcostaphylus* spp.
Peas	*Pisum* spp.	Juniper berries	*Juniperus* spp.
Spinach	*Spinacia oleracea*	Yucca	*Yucca* spp.
Rhubarb	*Rheum rhabarbarum*		
Melon	*Cucumis* spp.		
Pumpkin	*Cucurbita* spp.		
Watermelon	*Citrullus lanatus*		
Broccoli	*Brassica oleracea*		
Potato	*Solanum tuberosum*		
Tomato	*Lycopersicon lycopersicum*		
Grapes	*Vitis* spp.		
Apples	*Malus sylvestris*		
Pears	*Pyrus communis*		
Peaches	*Prunus persica*		
Tulip	*Tulipa* spp.		
Graph Hyacinth	*Muscari* spp.		
Crocus	*Crocus* spp.		

Appendix 4. Available plants typically not eaten by urban-dwelling javelina in Prescott, Arizona, 1992-93.

Ornamental		Native	
Common Name	Scientific Name	Common Name	Scientific Name
Chilipeppers	*Capsicum annuum*	Juniper trees	*Juniperus* spp.
Eggplant	*Solanum melongena*	Oak trees	*Quercus* spp.
Cucumbers	*Cucumis sativus*	Pine trees	*Pinus* spp.
Spruce trees	*Picea* spp.	Cottonwood trees	*Populus* spp.
Fir trees	*Abies* spp.	Shrub Live Oak	*Quercus turbinella*
Maple trees	*Acer* spp.	Skunkbush	*Rhus trilobata*
Juniper shrubs	*Juniperus* spp.	Mtn. Mahogany	*Cercocarpus* spp.
Rosebush	*Rosa* spp.	Deerbrush	*Canothus* spp.
Pampas grass	*Cortaderia selloana*	Silktassel	*Garrya wrightii*
Rosemary	*Rosemarinus* spp.	Manzanita	*Arctostaphylus* spp.
Basil	*Ocimum* spp.		
Sage	*Salvia officinalis*		
Lilac	*Syringa* spp.		
Iris	*Iris* spp.		
Daffodil	*Narcissus* spp.		
Petunia	*Petunia hybrida*		
Pansies	*Viola* spp.		
Violas	*Viola* spp.		
Allysum	*Allysum* spp.		
Carnations	*Dianthus* spp.		
Red-hot poker	*Kniphofia uvaria*		
Iceplant	*Mesembryanthemum*		
Easter lily	*Lilium longiflorum*		
Daylily	*Hemerocallis* spp.		
Gladiola	*Gladiolus* spp.		
Portulaca	*Portulaca grandiflora*		
Globe Amaranth	*Gomphrena* spp.		
Hibiscus	*Hibiscus* spp.		
Marigolds	*Tagetes* spp.		
Zinnia	*Zinnia* spp.		
Chrysanthemum	*Chrysanthemum* spp.		
Hen and chicks	*Echeveria elegans*		
Peonies	*Paeonia* spp.		
Butterfly bush	*Buddleia* spp.		
Santolina	*Santolina* spp.		
Ivy	*Hedera* spp.		
Geranium	*Geranium* spp.		
Dahlia	*Dahlia* spp.		
Cosmos	*Cosmos* spp.		
Vinca	*Vinca* spp.		
Sweet William	*Dianthus barbatus*		
Snapdragon	*Antirrhinum majus*		
Larkspur	*Consolida ambigua*		

Appendix 5. Fencing specifications for urban-dwelling javelina in Prescott, Arizona, 1992-93.

The following fencing specifications may be used to fence an entire yard or just a specific area such as a flower or vegetable garden.

Type:

1. Woven-wire

Any woven-wire mesh fencing material, with a gauge greater than chicken-wire, will be strong enough to prevent javelina from tearing through it. Whichever wire is used it must be strongly supported with durable wooden or steel posts. If possible the posts should be set in concrete. Javelina will try to force a flimsy fence by pushing it over.

The mesh holes should be small enough (<3 in. diameter) to prevent a pigling javelina from squeezing through and becoming separated from the rest of the herd. The mother may remain nearby waiting for its young and could become aggressive protecting it.

Fences should be at least 3 ft. high to prevent javelina from jumping over. Fences also should be flush with the ground, or even partially underground to prevent javelina or other animals from pulling the bottom up.

Some homeowners have successfully protected their bulbs from javelina by laying a piece of mesh fencing between the buried bulb and the ground surface.

2. Electric hot-wire

Electrical hot-wire fences are extremely effective in preventing javelina intrusion. They are also much less expensive and easier to install than wire-mesh fencing. Although many homeowners associations prohibit fence construction many are now allowing hot-wires because they are not visually obtrusive. In fact, hot-wire fencing is so easy to install it can be taken down for a special event, such as a garden show, and then replaced the next day. Furthermore, in Prescott, many areas are too rocky to construct other fence types.

Electric fence systems contain an electric fence charger which converts a power source (electric outlet, battery charged, or solar) into a pulsating, nonlethal, shocking current. A single strand of bare wire is held by insulators and attached to stakes placed into the ground (Fig 19). This wire carries the electrical current. When an animal that is standing on the ground touches this wire it receives a shock. Since birds perched on the wire are not touching the ground they will not receive a shock.

The most commonly used electric fence system is a 110-volt electric fence charger. Battery operated and solar powered chargers can also be used. Electric fence systems can be purchased in most hardware stores for as low as $35.00, depending on the voltage and type. A 17-gauge galvanized wire is commonly used with these systems.

Electric fence wires should be placed at javelina nose level (8-10 in.) from the ground. The hot-wire only needs to be turned on at night when javelina are active in urban areas. However, javelina are also active during daytime in winter. A photoelectric control switch can be installed to automatically turn the hot-wire on and off. In fact, this switch can be connected to yard night lights. Generally, once the entire herd has come into contact with the hot-wire it may be turned off. Surrounding vegetation must not touch the hot-wire as it will short the system.

To keep people from accidently walking into the hot-wire, pieces of flagging tape or cloth can be hung on the wire. However, it is important to keep flagging from touching the ground, vegetation, or other objects as it will interrupt the current.

3. Other (brick walls, wood-slat)

These fence types will also prevent javelina intrusion as long as they are tall enough (>1 m) to prevent javelina from jumping over the top and without holes or gaps (<8 cm diameter) that piglings may squeeze or crawl through.

- NOTES -

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Abstract: Conflicts between homeowners and urban-dwelling javelina (*Tayassu tajacu*) in Prescott, Arizona, prompted studies to develop recommendations to alleviate these conflicts. We captured, telemetered, and located javelina during 1992-93 to determine home ranges, habitat use, and activity patterns in urban areas. Urban-dwelling javelina exhibited comparable social and territorial behavior to nonurban javelina; however, they adjusted their home ranges, home-range overlap, habitat use, and activity patterns to best use urban food, water, and cover. Urban-dwelling javelina selected for sites with an open woodland overstory combined with a mixed shrub understory in both developed and undeveloped areas. Urban-dwelling javelina fed on bird seed that fell from feeders, pet foods, garden tubers and other foods provided by homeowners. Bird baths and pet water dishes were supplemental water sources. Undeveloped land within or adjacent to Prescott provided javelina with daytime bedding areas. Undeveloped areas between homes provided javelina with nighttime travel corridors. Additionally, human-made structures substituted for natural escape cover from people and from adverse weather conditions. Human-javelina conflicts often occurred when javelina responded to urban attractants and destroyed ornamental landscapes or injured pets. Of the 98% of homeowners that liked wildlife in their yard, 61% preferred the wildlife not be javelina. Stepwise logistic regression of homeowner questionnaire data indicated that 3 variables were most useful in distinguishing between those yards with and those without javelina encounters. These variables were: length of residency; whether occupants fed wildlife other than javelina; and availability of ornamental plants.

Key Words: activity patterns, Arizona, collared peccary, habitat selection, home ranges, javelina, movements, nuisance wildlife, *Tayassu tajacu*, urban

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